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AIR BAG MODULE VENT WITH RELEASABLE LATCH

Related Applications

This application is a continuation-in-part of U.S. patent application Serial No. 10/244,933, filed September 5 16, 2002.

Background of the Invention

The present invention relates to a vehicle occupant protection apparatus. In particular, the present invention relates to an air bag module including a vent with a vent door that is moved between an open condition and a closed condition by a tether of an air bag.

Description of Related Art

It is known to provide an air bag with a vent. The vent is operative, when the air bag inflates to help protect a vehicle occupant, to discharge inflation fluid from the air bag. In some air bags, the vent may be selectively opened depending on sensed factors, for

example, whether the occupant's seat belt is buckled. In other air bags, such as the one shown in U.S. Patent No. 5,405,166, the vent is formed as two openings that are initially aligned so that the vent is initially open and
5 then closes after the internal bag pressure reaches a predetermined amount. U.S. Patent No. 5,246,250 shows an air bag that includes a tether attached to a valve flap panel to open or close a vent opening in the air bag when the air bag is inflated and the tether is actuated.

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Summary of the Invention

The present invention relates to an apparatus that includes an inflatable vehicle occupant protection device inflatable to deploy from a deflated condition to an inflated condition. A vent opening directs flow of inflation fluid away from the protection device. A vent member is movable relative to the vent opening between an open condition enabling flow of inflation fluid away from the protection device through the vent opening and a closed condition at least partially blocking flow of inflation fluid away from the protection device through the vent opening. A member is associated with the protection device and the vent member. The member is operative to move the vent member from the open condition

to the closed condition upon deployment of the protection device. Latching means has a latched condition for maintaining the vent member in the closed condition and an unlatched condition for preventing the vent member from remaining in the closed condition. Control means is operative to actuate the latching means selectively to the latched condition and the unlatched condition based on at least one sensed occupant condition.

The present invention also relates to a vehicle occupant protection apparatus including an inflatable vehicle occupant protection device inflatable to deploy from a deflated condition to an inflated condition. A vent opening enables flow of inflation fluid away from the protection device. A vent member is movable relative to the vent opening between an open condition enabling flow of inflation fluid away from the protection device through the vent opening and a closed condition at least partially blocking flow of inflation fluid away from the protection device through the vent opening. A tether is connected to the protection device. The protection device pulls on the tether during inflation and deployment. Connecting means including a velocity mechanism is operable to release the tether for movement relative to the vent member when the tether is pulled at a velocity below a predetermined

velocity. The velocity mechanism is further operable to lock the tether against movement relative to the vent member when the tether is pulled at a velocity at or above the predetermined velocity. The tether is operative to move the vent member from the open condition to the closed condition when the protection device pulls on the tether and the velocity mechanism locks the tether.

Brief Description of the Drawings

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon consideration
5 of the following description of the invention with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view of a portion of a vehicle occupant protection apparatus including an inflatable driver side protection device and a vent in accordance
10 with the present invention, with the vent being in an open condition;

Fig. 2 is a view similar to Fig. 1 showing the apparatus with the vent in a closed condition;

Figs. 3A-3C are magnified views of a portion of the
15 apparatus of Figs. 1 and 2 with parts shown in different

positions, according to a first embodiment of the present invention;

Fig. 4 is a block diagram illustrating a vehicle safety system of the present invention;

5 Fig. 5 is a magnified view of a portion of the apparatus of Figs. 1 and 2, according to a second embodiment of the present invention; and

Figs. 6A and 6B are magnified views of the portion of the apparatus of Fig. 5, with parts shown in different
10 positions.

Detailed Description of the Invention

The present invention relates to a vehicle occupant protection apparatus. In particular, the present invention relates to an air bag module having a vent that
15 is moved between an open condition and a closed condition by a tether of an air bag. The vent is held in the closed condition by a latch mechanism that is selectively releasable depending on sensed conditions.

As representative of the invention, Figs. 1 and 2
20 illustrate schematically an air bag module 10 that includes an inflatable occupant protection device in the form of an air bag 12. Other vehicle occupant protection devices that can be used in accordance with the invention

include, for example, inflatable seat belts, inflatable knee bolsters, inflatable head liners, inflatable side curtains, and knee bolsters operated by inflatable air bags.

5 The air bag module 10 of the illustrated embodiment is a front impact air bag module mountable on a driver side or passenger side of a vehicle. For example, in a driver side implementation, the air bag module 10 may be mounted on a steering wheel of the vehicle. In a
10 passenger side implementation, the air bag module 10 may be mounted in an instrument panel of the vehicle.

 The air bag 12 is preferably made from a flexible fabric material, such as woven nylon, and has an inflation fluid volume 14. The air bag 12 can alternatively be made
15 from a non-woven material, such as plastic film.

 The module 10 includes an inflator 16 for inflating the air bag 12. The inflator 16 may contain a stored quantity of pressurized inflation fluid and an ignitable material for heating the inflation fluid. The module 10
20 alternatively could include an inflator 16 that uses the combustion of gas generating material to generate inflation fluid in the form of gas to inflate the air bag 12. As another alternative, the inflator 16 may contain only a stored quantity of pressurized inflation fluid for

inflating the air bag 12. As a further alternative, the inflator 16 may have any known configuration suitable for providing inflation fluid for inflating the air bag 12.

The inflator 16 and the air bag 12 are supported on a
5 support member 20. The support member 20 is a member or assembly that is fixed in position on the vehicle, that supports the inflator 16 and the air bag 12, and that receives the reaction forces of the inflator and the air bag when the inflator is actuated. In the illustrated
10 embodiment, the support member 20 is a reaction plate.

The reaction plate 20 is a single piece of material, such as metal or high strength plastic, that is formed to the illustrated configuration. The reaction plate 20 has a main body portion 22 centered on an axis 24. A rim or
15 outer wall 26 of the reaction plate 20 extends downward (as viewed in Fig. 1) from the main body portion 22. An inner wall 28 of the reaction plate 20 extends downward from the main body portion 22 and parallel to the outer wall 26, at a location spaced inward from the outer wall
20 26. A center wall 30 caps the inner wall 28.

The inner wall 28 and the center wall 30 of the reaction plate 20 define an inflator mounting chamber 32. The inflator 16 is located in the chamber 32 and is secured to the reaction plate 20 in a manner not shown.

The inner wall 28 and the outer wall 26 of the reaction plate 20 define a vent chamber 34 positioned outward of the inflator mounting chamber 32.

A mouth portion 36 of the air bag 12 is secured to
5 the main body portion 22 of the reaction plate 20 by a
retainer or retainer ring 54. The mouth portion 36
defines an inflation fluid opening 40 for receiving
inflation fluid from the inflator 16. The inflation fluid
opening 40 allows inflation fluid to flow from the
10 inflator 16 into the inflation fluid volume 14 of the air
bag 12 when the inflator is actuated. Opposite the mouth
portion 36, the air bag 12 has an outer panel 42 that is
located distant from the reaction plate 20 when the air
bag is inflated.

15 The air bag module 10 also includes inflation fluid
vents 38. In the embodiment illustrated in Figs. 1 and 2,
the air bag module 10 includes two vents 38. The module
10 could, however, include more or fewer vents 38, which
could be positioned differently than illustrated. The two
20 vents 38 illustrated in Figs. 1 and 2 are identical. Each
vent 38 includes a vent opening 44 and a vent member 46.
The vent members 46 are operative selectively to close
their respective vent opening 44.

The vent openings 44 are formed in the main body portion 22 of the reaction plate 20 and are positioned inward of the mouth portion 36 of the air bag 12. The vent openings 44 are identical to each other, each having
5 a generally rectangular configuration. The vent openings 44 could, however, have configurations other than a rectangular configuration, and if plural vents 38 are provided, they could have configurations different from each other.

10 Because the vent openings 44 are located in the main body portion 22 of the reaction plate 20 inward of the mouth portion 36 of the air bag 12, the vent openings are in fluid communication with the inflation fluid volume 14
15 of the air bag. As a result, at least some of the inflation fluid flowing from the inflator 16, when the inflator is actuated, flows across or into the vent openings 44 in the reaction plate 20.

Each vent member 46 is configured as a rectangular door that is supported on the reaction plate 20 for
20 pivotal movement relative to the reaction plate. The door 46 is pivotally mounted to the reaction plate at a location adjacent the mouth portion 36 of the air bag 12. The module 10 includes latch mechanisms shown schematically at 48 on the inner wall 28 of the reaction

plate 20, adjacent each vent opening 44. Each latch mechanism 48 is actuatable to a latched condition (see Figs. 3A and 3B) and an unlatched condition (see Fig. 3C). The latch mechanism 48 will be described in further detail
5 below.

Each door 46 has a first condition shown in Fig. 1 in which the door is spaced apart from the vent opening 44 in the reaction plate 20. When the door 46 is in the first condition, the door is pivoted away from the vent opening
10 44 and away from the inflation fluid volume 14 of the air bag 12 (downward as viewed in Fig. 1), into the vent chamber 34 in the reaction plate 20. When the door 46 is in the first condition, the vent 38 is in an open condition and the vent opening 44 is not blocked.
15 Inflation fluid can thus flow away from the air bag 12 through the vent opening 44 of the vent 38.

Each door 46 has a second condition shown in Fig. 2 in which the door is pivoted upward and overlies the vent opening 44 in the reaction plate. The latch mechanism 48
20 when in the latched condition holds the door 46 in the second or closed condition. When the door 46 is in the closed condition, the vent 38 is in a closed condition and the vent opening 44 is at least partially blocked. This

helps block inflation fluid from flowing away from the air bag 12 through the vent opening 44 of the vent 38.

The module 10 includes one or more tethers 50 for controlling or limiting deployment of the air bag 12. In the illustrated embodiment, two identical tethers 50 are provided, each corresponding to a respective one of the vents 38 and, more particularly, to a respective one of the vent doors 46. The tethers 50 in accordance with the present invention may take any one of many different forms. In the illustrated embodiment, each tether 50 is a narrow, elongate piece or strip of fabric material having a width of from about one-half inch to about two inches. The tether 50 may be made from the same material as the air bag 12 or may be made from a different material. The tethers 50 are not, per se, part of the air bag 12, in the sense that the air bag can deploy and inflate regardless of whether the tethers are present or not.

Each tether 50 has a first end portion 52 that is fixed to the outer panel 42 of the air bag 12 by means (not shown), such as sewing. The first end portion 52 of the tether 50 is thus connected for movement with the air bag 12 as the air bag is deployed.

An opposite second end portion 56 of each tether 50 is connected with or fixed to its respective vent door 46.

The tethers 50, when tensioned by the air bag 12, transfer tensile force from the air bag and the tethers to their respective vent doors 46. The second end portions 56 of the tethers 50 may be formed as loops that extends through
5 or around a portion of their respective doors 46 to couple the doors for movement with the second end portions of the tethers. The second end portions 56 of the tethers 50 may be secured to the vent doors 46 in another manner, for example, by adhesive. Each tether 50 includes an
10 intermediate portion 58 that extends between and interconnects its first and second end portions 52 and 56.

When the air bag 12 is in a deflated condition (not shown), the outer panel 42 of the air bag is close to or adjacent the mouth portion 36. There is a significant
15 amount of slack in the tethers 50. The slack is present because the length of each tether 50 is greater than the distance between the portion of the air bag 12 where the first end portion 52 of the tether is fixed to the outer panel 42 and the location on the vent door where the
20 second end portion 56 of the tether is connected to the door. In the illustrated embodiment, the slack is provided by the intermediate portions 58 of the tethers 50. Because of the presence of the slack, the vent doors 46 are not pulled closed against the reaction plate 20

when the air bag 12 is in the deflated condition, and inflation fluid may be able to flow away from the air bag through the vent openings 44.

If the air bag 12 is to be inflated, an actuation
5 signal is transmitted to the inflator 16. When the inflator 16 is actuated, it emits a large volume of inflation fluid through the mouth portion 36 of the air bag 12 and into the inflation fluid volume 14 of the air bag. The air bag 12 inflates, as shown in Figs. 1 and 2.

10 As the air bag 12 inflates, the outer panel 42 of the air bag moves away from the reaction plate 20 and the vent doors 46. Referring to Fig. 1, when the air bag 12 is inflated, the outer panel 42 may move away from the reaction plate 20 by less than a predetermined distance.
15 This might happen, for example, if the air bag 12 when inflating contacts a vehicle occupant (as shown schematically at 62 in Fig. 1) positioned relatively close to the reaction plate 20.

The engagement of the air bag 12 with the relatively
20 close vehicle occupant 62 stops or limits outward movement of the outer panel 42 of the air bag. When this occurs, the tethers 50 are not stretched out sufficiently to remove the slack from the tethers. The tethers 50 do not pull on the vent doors 46, and the vent doors remain in

the first condition, spaced apart from the vent openings 44. The vent openings 44 thus remain open, enabling flow of inflation fluid away from the air bag 12 through the vent openings. This venting of the air bag 12 can reduce the force and pressure with which the air bag inflates.

Referring to Fig. 2, when the air bag 12 is inflated, the outer panel 42 may move away from the reaction plate 20 by a predetermined amount. Such movement might occur if the air bag 12 inflates fully to help protect a vehicle occupant seated against the vehicle seat back. This movement of the outer panel 42 away from the reaction plate 20 by the predetermined amount causes the tethers 50 to be tensioned, as shown in Fig. 2. As the distance between the first and second end portions 52 and 56 of the tethers 50 increases, the slack is pulled out of the tethers and the tethers pull the vent doors 46 to the second or closed condition shown in Fig. 2. The vent openings 44 are thus closed, blocking flow of inflation fluid away from the air bag 12 through the vent openings. If the latch mechanisms 48 are in the latched condition when the vent doors 46 are closed, the latch mechanisms latch the doors closed and the air bag 12 inflates with full force and pressure.

According to the present invention, the latch mechanisms 48 are selectively actuatable between the unlatched and latched conditions and thus may selectively release the vent doors 46 to move from the closed
5 condition (Fig. 2) to the open condition (Fig. 1). The latch mechanisms 48 are shown in greater detail in Figs. 3A-3C.

The latch mechanism 48 includes a latch member 60 connected to a shaft 62 of an actuator 64. Actuation of
10 the actuator 64 is initiated by a signal provided to the actuator from a controller (not shown) via lead wires 74. Operation of the controller is described below.

When the latch mechanism 48 is actuated to the latched condition, the shaft 62 is moved in a first
15 direction, downward as viewed in Figs. 3A-3C, to the latched position illustrated in Figs. 3A and 3B. The first direction is indicated generally by the arrow 70 in Figs. 3A and 3B. When the actuator 64 is actuated to the unlatched condition, the shaft 62 is moved in a second
20 direction, opposite the first direction and upward as viewed in Figs. 3A-3C, to the unlatched position illustrated in Fig. 3C. The second direction is indicated generally by the arrow 72 in Fig. 3C.

If the latch mechanism 48 is in the latched condition when the vent door 46 moves from the opened condition (Fig. 3A) toward the closed condition (Fig. 3B), the door engages the latch member 60 and urges the member in the second direction 72. The vent door 46 displaces the latch member 60 and slides past the latch member to the closed condition of Fig. 3B. Once the door 46 moves beyond the latch member 60, the latch member returns to the latched condition of Fig. 3B. The vent door 46 is thus locked in the closed condition and blocks inflation fluid flow through the vent opening 44.

If the latch mechanism 48 is in the unlatched condition when the vent door 46 moves from the opened condition (Fig. 3A) toward the closed condition (Fig. 3C), the latch member does not latch the door in the closed position. The latch mechanism 48, when in the unlatched condition of Fig. 3C, helps prevent the vent door 46 from remaining in the closed condition. When the latch mechanism 48 is in the unlatched condition, inflation fluid pressure in the air bag 12 urges the door 46 to the opened condition. The inflation fluid in the air bag 12 may thus flow from the inflation fluid volume 14 through the vent opening 44, as indicated by the arrows in Fig. 3C.

According to the present invention, the actuator 64 may have a variety of configurations. For example, the actuator 64 may comprise a solenoid 80 actuatable to move the shaft 62 and latch member 60 between the latched
5 condition (Figs. 3A and 3B) and the unlatched condition (Fig. 3C). In this configuration, the solenoid 80 is actuatable by an electrical actuating signal provided via the lead wires 74.

As another example, the actuator 64 may comprise a
10 solenoid 80 in which the shaft 62 and latch member 60 are spring biased in the first direction 70 to the latched condition. The solenoid 80 is actuatable by an electrical actuating signal provided via the lead wires 74 to move the shaft 62 and latch member 60 in the second direction
15 72 to the unlatched condition. The latch member 60 is thus maintained in the unlatched condition as long as the actuating signal is present.

As another example, the solenoid 80 may be a latching solenoid. In this configuration, once the shaft 62 and
20 latch member 60 are moved to the latched or unlatched condition, they are maintained in that respective condition mechanically. As a result, a pulsed actuating signal is sufficient to actuate the solenoid 80 to move the latch member 60 to the unlatched condition and

maintain the member in the unlatched condition. Likewise,
another pulsed actuating signal is sufficient to actuate
the solenoid to move the latch member to the latched
condition and maintain the member in the latched
5 condition.

As a further example, the actuator 64 may comprise a
piston actuator 82, in which the shaft 62 is operatively
connected to a piston (not shown) slidable in a cylinder.
The piston is actuatable to move the shaft 62, and thus
10 the latch member 60 to the actuated and unactuated
conditions. In such a configuration, the piston may be
actuatable hydraulically, pneumatically, or
pyrotechnically.

Those skilled in the art will appreciate that the
15 latch mechanism 48 may have configurations alternative to
those described above. For example, the latch mechanism
48 could include a permanent magnet for latching the vent
door 46 in the closed condition. This configuration may
include an electromagnet that, when energized, produces a
20 magnetic field that overcomes or cancels the magnetic
field of the permanent magnet, thereby to release the vent
door 46 to move to the opened condition.

According to the present invention, the air bag
module 10 is implemented in a vehicle occupant protection

system for helping to protect an occupant of a vehicle. Referring to Fig. 4, the vehicle occupant safety system 100 includes a controller 102 operatively connected to the latch mechanism 48 by the lead wires 74.

5 The controller 102 is operatively connected to a variety of sensors for sensing various conditions of the vehicle and/or vehicle occupant. As shown in Fig. 4, these sensors may include vehicle collision and/or rollover sensors 110, occupant position sensors 112, seat
10 position sensors 114, seat belt latch sensors 116, seat weight sensors 118, seat belt tension sensors 120, or any other sensors 122 that may be useful in determining whether to release the vent door to the opened condition.

As stated above, the controller 102 is operative to
15 actuate the latch mechanism 48 selectively between the unlatched condition and the latched condition based on sensed occupant and/or vehicle conditions. Generally speaking, based on the sensed vehicle and occupant conditions, the controller 102 determines the appropriate
20 pressure to which to inflate the air bag 12. If the controller 102 determines the need to maintain a relatively high inflation pressure for the air bag, the controller is operative to maintain the vent door 46 latched closed to help prevent inflation fluid from

venting from the air bag 12. If the controller 102 determines the need to provide a lower inflation pressure for the air bag, the controller is operative to release the vent door 46 to open so that inflation fluid vents
5 from the air bag 12. The controller 102 may also be operative to initially latch the vent door 46 to maintain a relatively high inflation pressure and subsequently release the vent door to open and release inflation fluid.

For example, in a situation where the occupant is
10 positioned away from the normal seated position, the configuration of the tethers 50 may inherently control closing of the vent doors 46. This may be the case, for example, where the occupant is leaned forward close to the air bag module 10. In this situation, the occupant may
15 impede deployment of the air bag 12. This may prevent tensioning of the tethers 50, in which case the tethers would not pull the vent door 46 to the closed condition. Therefore, in this situation, air bag module 10 may function passively to cause the vent door 46 to remain in
20 the opened condition.

The occupant could, however, be positioned away from the normal seated position and yet the tethers 50 still function to pull the vent door 46 to the closed condition. This may be the case, for example, where the occupant is

leaned to the side of the air bag module 10. In this situation, the position of the occupant may be determined by the occupant position sensors 112. In this situation, the controller 102 may be operative to actuate or maintain
5 the latch mechanism 48 to the unlatched condition, thus releasing the vent doors 46 to vent inflation fluid from the air bag 12 (see Fig. 1).

As another example, the occupant may be in the normal seated position but not restrained by the vehicle seat
10 belt. This situation may be determined via the seat belt latch sensor 116 and the occupant position sensor 112. If this situation is detected, the controller 102 may be operative to actuate or maintain the latch mechanism 48 in the latched condition. This prevents inflation fluid from
15 venting, which allows the air bag 12 to inflate fully and remain inflated throughout the duration of the collision. As a result, the air bag 12 may provide a high level of energy absorption for helping to restrain the unbelted occupant.

20 As a further example, the occupant may be in the normal seated position and restrained by the vehicle seat belt. This situation may be determined via the seat belt latch sensor 116. If this situation is detected, the controller 102 may be operative to actuate or maintain the

latch mechanism 48 in the unlatched condition. This releases the vent doors 46 to vent inflation fluid from the air bag 12. This permits inflation fluid to vent from the air bag 12, which provides a ride down effect.

5 Those skilled in the art will appreciate that situations other than those set forth above may be sensed and used by the controller 102 to control operation of the latch mechanism 48. It will also be appreciated that the other sensors, i.e., the seat position sensor 114, seat
10 weight sensor 118, seat belt tension sensor 120, and other sensors 122, may provide information that the controller 102 may use to control actuation of the latch mechanism 48 further. For example, information provided by the seat position sensor 114 and seat weight sensor 118 and seat
15 belt tension sensor 120 may be used by the controller 102 to help predict the size and position of the occupant. The controller 102 may then further control actuation of the latch mechanism 48 to provide the energy absorption characteristics required for the sensed occupant. As
20 another example, the seat belt tension sensor 120 may be used to detect the presence of a child safety seat.

The vents 38 of the air bag module 10 thus function in a passive mode in which the air bag 12 and tether 50 operate to place the vent in the closed condition

depending upon actual occupant conditions, such as the position of the occupant relative to the air bag.

Meanwhile, the latch mechanism 48 functions in an active mode in which the latch mechanism is actuated by the

5 controller 102 to place the latch mechanism selectively in the actuated or unactuated condition based on sensed occupant conditions.

The controller 102 may be operative to sense vehicle and/or occupant conditions and place the latch mechanisms
10 48 in the actuated or unactuated condition independently of whether an event for which deployment of the air bag 14 has occurred. The controller 102 may thus operate in realtime, continuously evaluating data regarding the vehicle and/or occupant conditions provided by the sensors
15 and actuating the latch mechanisms to the appropriate condition. For example, the controller 102 may be operatively connected to the seat belt latch sensor 116 and continuously monitor the condition of the seat belt while the vehicle is in operation. In this scenario, the
20 controller 102 may be operative to place the latch mechanisms 48 in the latched condition whenever an unlatched condition of the seat belt is sensed, may be operative to place the latch mechanisms in the unlatched condition whenever a latched condition of the seat belt is

sensed. In this scenario, the controller 102 would actuate the latch mechanisms 48 regardless of whether an event for which deployment of the air bag is sensed.

A second embodiment of the present invention is illustrated in Fig. 5. The second embodiment of the invention is similar to the first embodiment of the invention illustrated in Figs. 1-4. Accordingly, numerals similar to those of Figs. 1-4 will be utilized in Fig. 5 to identify similar components, the suffix letter "a" being associated with the numerals of Fig. 5 to avoid confusion. The second embodiment of the present invention is similar to the first embodiment (Figs. 1-4), except that the tether of the second embodiment is connected to the vent door by a velocity mechanism.

Referring to Fig. 5, the vent 38a of the air bag module 10a includes a velocity mechanism 120, supported on the vent door 46a, for receiving the tether 50a. The velocity mechanism 120 includes a spool 122 around which the tether 50a is looped. The spool 122 has an outer surface adapted to promote frictional engagement between the tether 50a and the spool. To achieve this frictional engagement, the outer surface of the spool 122 may, for example, include teeth or may be roughened.

The velocity mechanism 120 is configured to allow the spool 122 to spin freely about a central longitudinal axis 124 at an angular velocity below a predetermined level. The velocity mechanism 120 is further adapted to lock
5 against rotation about the axis 124 when the angular velocity is at or above the predetermined level.

During inflation of the air bag 12a, the tether 50a is pulled by the air bag in the direction indicated by the arrow in Fig. 5. The tether 50a imparts rotational
10 movement to the spool 122. Once the tether 50a is pulled at a velocity sufficient to cause the spool 122 to lock, the velocity mechanism 120 grabs onto the tether. When the velocity mechanism 120 grabs onto the tether 50a, further movement of the tether pulls the vent door 46a
15 closed.

By way of example, a configuration for the velocity mechanism 120 is illustrated in Figs. 6A and 6B. As shown in Figs. 6A and 6B, the spool 122 is supported for rotation about the axis 124 on a pivot arm 130. The pivot
20 arm 130 is pivotable about a pivot axis 132 and is biased to a retracted position illustrated in Fig. 6A by a spring 134. In the retracted position, there is a clearance between a toothed outer surface 140 of the spool 122 and a toothed surface 142 of the vent door 46a. This clearance

is sufficient to allow the tether 50a to move freely between the toothed surfaces 140 and 142.

The velocity mechanism 120 also includes a cog 150 that is centered on the axis 124. The cog 150 is fixed
5 and not permitted to rotate about the axis 124. A pawl 152 is fixed to the spool 122 and is pivotable about an axis 154 that is offset from the axis 124. The pawl 152 has a central cutout portion 160 that forms an inner surface on which a pair of teeth 162 are formed. The pawl
10 is biased by means (not shown), such as a spring, to a normal position, illustrated in Fig. 6A. The cog 150 fits within the cutout portion 160 of the pawl 152.

When the pawl 152 is in the normal position of Fig. 6A, the teeth 162 are spaced from the cog 150. The spool
15 122 along with the pawl 152 is thus free to rotate about the axis 124. Therefore, when the tether 50a is tensioned in the direction indicated generally by the arrow labeled 170, the spool 122 rotates in the direction indicated generally by the arrow labeled 172.

20 As the spool 122 rotates about the axis 124, centrifugal and other forces act on the pawl 152, urging the pawl to pivot relative to the spool about the axis 154. When the spool 122 reaches a predetermined rotational speed, the forces acting on the pawl 152 become

sufficient to overcome the spring bias maintaining the pawl in the normal position of Fig. 6A. As a result, pawl 152 pivots about the axis 154 against the spring bias toward a locking position, which is illustrated in Fig.

5 6B. This predetermined rotational speed may be selected in a variety of manners, such as altering the bias of the spring biasing the pawl 152 or altering the shape or mass of the pawl.

When the pawl 152 rotates in the direction 172 at or
10 above the predetermined speed, the pawl 152 pivots in the direction indicated generally by the arrow labeled 174 to the locking position of Fig. 6B. As a result, one of the teeth 162 (i.e., the tooth on the right as viewed in Fig. 6B) engages the cog 150. Since the cog 150 is fixed
15 against rotation about the axis 124, engagement of the pawl 152 with the cog blocks the spool 122 against rotation about the axis 124. Since the spool 122 is blocked against rotation, the tension on the tether 50a is transferred to the pivot arm 130. This tension urges the
20 pivot arm 130 to pivot about the axis 132 against the bias of the spring 134.

The pivot arm 130 pivots about the axis 132 in a direction indicated generally by the arrow labeled 176 in Fig 6B. As a result, the toothed surface 140 of the spool

122 moves toward the toothed surface 142 of the vent door 46a, closing the clearance and exerting a clamping force on the tether 50a. The velocity mechanism 120 thus grabs onto the tether 50a and the tension on the tether is transferred to the vent door 46a so that the door moves toward the closed condition (see Fig. 5). Increased tension on the tether 50a increases the clamping force exerted on the tether and thus increases the force with which the velocity mechanism 120 grabs the tether.

Those skilled in the art will appreciate that the velocity mechanism 120 may grab the tether 50a prior to the air bag 12a becoming fully inflated. Because of this, it may be desirable to connect the tether 50a to the air bag 12a using a releasable fastening means, such as tear stitches. As a result, once the vent door 46a is closed, increased tension on the tether 50a due inflation of the air bag 12a will cause the tear stitching to tear, thus releasing the air bag for further inflation.

Advantageously, inclusion of the velocity mechanism 120 allows the vent door 46a to be closed upon the tether 50a reaching the predetermined velocity instead of when the air bag 12a becomes fully inflated. The tether 50a reaching the predetermined velocity may indicate the presence of a clearance between the air bag module and the

vehicle occupant sufficient to warrant closing the vent door 46a. Accordingly, the vent door 46a may thus be pulled closed immediately instead of when the air bag reaches its fully inflated condition. The vent door 46a, 5 once closed, may be maintained closed or released to open by the latch mechanism 48a (Fig. 5) in the manner described above in regard to the first embodiment of Figs. 1-4.

From the above description of the invention, those 10 skilled in the art will perceive improvements, changes and modifications in the invention. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.